FOREST GLEN SUBDIVISION SUPERFUND SITE
NIAGARA COUNTY, NEW YORK

QUALITY ASSURANCE PROJECT PLAN

FOR THE

EAST GILL CREEK, GILL CREEK, AND HYDE PARK LAKE CHARACTERIZATION STUDY

PREPARED FOR

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
7600 SAND POINT WAY NE
SEATTLE, WASHINGTON 98115

FOREST GLEN SUBDIVISION SUPERFUND SITE
NIAGARA COUNTY, NEW YORK

QUALITY ASSURANCE PROJECT PLAN FOR THE EAST GILL CREEK, GILL CREEK, AND HYDE PARK LAKE CHARACTERIZATION STUDY

Prepared for

National Oceanic and Atmospheric Administration

Prepared by

RIDOLFI Inc.
and
National Oceanic and Atmospheric Administration

September 2005

APPROVAL SHEET

Coastal Resources Coordinator:

____ ____________________
Jennifer Lawton Date
National Oceanic and Atmospheric Administration

Project Manager:

____ ____________________
Jennifer Lawton Date
National Oceanic and Atmospheric Administration

Project QA Coordinator:

____ ____________________
Robert Dexter Date
RIDOLFI Inc.

DISTRIBUTION LIST

- ❑ Jennifer Lawton, NOAA
- ❑ Benjamin Shorr, NOAA
- ❑ Colin Wagoner, RIDOLFI Inc.
- ❑ Robert Dexter, RIDOLFI Inc.
- ❑ Megan Hilgart, RIDOLFI Inc.
- ❑ Mary Lou Fox, Analytical Resources, Inc.
- ❑ Edmund Canaria, EVS Environment Consultants Limited
- ❑ Mary Lou Hendry, Axys Analytical Services Ltd.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

ASTM	American Society for Testing and Materials
bgs	below ground surface
CLP	Contract Laboratory Program
COC	chain-of-custody
CVAA	cold vapor atomic absorption
dioxins/furans	polychlorinated dibenzo-p-dioxins and dibenzofurans
DO	dissolved oxygen
DQO	data quality objective
EDD	electronic data deliverable
FSP	Field Sampling Plan
GC/MS	gas chromatography/mass spectrometry
GC/ECD	gas chromatography/electron capture detector
GPS	global positioning system
HDPE	high-density polyethylene
HRGC/HRMS	high-resolution gas chromatography/high-resolution mass spectrometry
ICP/MS	inductively coupled plasma/mass spectroscopy
IDW	investigative-derived waste
LQAP	laboratory quality assurance plan
MS/MSD	matrix spike/matrix spike duplicate
NOAA	National Oceanic and Atmospheric Administration
NPL	National Priorities List
PAH	polycyclic aromatic hydrocarbon
PARCC	precision, accuracy, representativeness, completeness, and comparability
PCB	polychlorinated biphenyl
PE	polyethylene
PRP	Potentially Responsible Party
PSEP	Puget Sound Estuary Program
PTFE	polytetrafluoroethylene (Teflon)
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RPD	Relative Percent Difference

%RSD	percent relative standard deviation
SVOC	semi-volatile organic compound
TAL	Target Analyte List
TEC	Threshold Effect Concentration
TEL	Threshold Effects Level
TOC	total organic carbon
TRL	target reporting limit
UET	Upper Effects Threshold
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency

UNITS OF MEASURE

° C	degrees Celsius
mg/kg	milligrams per kilogram
μg/kg	micrograms per kilogram
μm	micrometer

1.0 INTRODUCTION AND SCOPE

This quality assurance project plan (QAPP) describes the general quality assurance (QA) and quality control (QC) procedures that will be implemented to ensure that data generated for this project are of sufficient quality to be used in decision-making associated with environmental characterization and cleanup. This QAPP has been prepared in general accordance with applicable guidance and requirements from the U.S. Environmental Protection Agency (USEPA) (USEPA 1989, 1998, 2001). This QAPP applies to the project activities involved in characterizing the nature, extent and toxicity of contamination in sediment in East Gill Creek, Gill Creek, and Hyde Park Lake downstream of the Forest Glen Subdivision Superfund site in Niagara, New York (Figure 1).

1.1 Problem Definition and Background

The Forest Glen Subdivision Superfund site is located in the City of Niagara Falls, New York and the Town of Niagara, New York. The site is approximately 39 acres, including an 11-acre former mobile home subdivision. Originally the site was primarily a wooded wetland. In the 1960s the land was cleared and in the 1970s low-lying areas were filled and the mobile home subdivision was developed. Illegal dumping of industrial waste occurred at the site from the 1950s through the 1970s. Soils on the site are contaminated with polycyclic aromatic hydrocarbons (PAHs) and other semi-volatile organic compounds (SVOCs).

In the 1980s, the Niagara County Health Department and the New York State Department of Environmental Conservation requested that USEPA list the site on the National Priorities List (NPL). Four Potentially Responsible Parties (PRPs) were involved in the remediation: Goodyear Tire and Rubber Company, Niagara Falls USA Camp Site, Inc., and two citizens. Between 1990 and 1992, 153 people were permanently relocated from the site.

In 2001, Goodyear reached a settlement with USEPA and natural resource trustees to resolve liability at the site in exchange for a remediation of the site, restoration of injured resources, and associated past costs. The National Oceanic and Atmospheric Administration (NOAA) issued a provisional covenant not to sue with the stipulation that additional sampling was needed to adequately characterize contamination downstream of the site. As part of the settlement, NOAA received support to conduct this sampling.

1.2 Project Task Description

The work covered by this QAPP includes sediment sampling, laboratory bioassays, and associated quality control and quality assurance. Section 2 describes the systematic planning process used in this project. Section 3 describes the field quality control requirements. Section 4 outlines the laboratory quality control procedures and the laboratory data deliverables for this project. Section 5 details data reduction, validation, management, and reporting. Sections 6 and 7 list the acronyms and references used in this document, respectively.

1.3 Project Organization: Roles and Responsibilities

Responsibilities of key personnel and of the QA Coordinators for specific field, laboratory, and data analysis tasks are described in the following sections.

Project Management. The Project Manager is responsible for overall project coordination, including the production of all project reports, and the collection and submittal of environmental samples to the designated laboratory for chemical and physical analyses as specified in this QAPP. The Project Manager is:

Jennifer Lawton, Associate Coastal Resource Coordinator
NOAA Office of Response and Restoration
77 West Jackson SR-6J
Chicago, IL 60604
Phone: 312-886-4663
Fax: 312-353-5541
E-mail: jen.lawton@noaa.gov

Quality Assurance. The Project QA Coordinator is responsible for finalizing this QAPP, coordinating with the analytical laboratory, ensuring data quality for chemical analyses, overseeing data validation, and supervising project quality assurance coordination. The Project QA Coordinator is:

Robert Dexter, Senior Scientist
RIDOLFI Inc.
1011 Western Ave., Suite 1006
Seattle, WA 98104
Phone: 206-682-7294
Fax: 206-682-5008
E-mail: bob@ridolfi.com

Laboratory Project Management. Laboratory project managers will provide analytical support to this project and are responsible for ensuring that all laboratory analyses meet the project objectives and other specifications detailed in this QAPP. The laboratory project managers are:

For chemical other than dioxins and furans:

Mary Lou Fox, Project Manager
Analytical Resources, Inc. (ARI)
4611 S. 134th Place
Seattle, WA 98168-3240
Phone: 206-695-6200
Fax: 206-695-6201
E-mail: marylou@arilabs.com

For dioxin and furan analyses:

Mary Lou Hendry, Project Manager
Axys Analytical Services, Ltd.(Axys)
2045 Mills Road
PO Box 2219
Sidney, BC V8L 3S8
Phone: 250-655-5800 or 888-373-0881
Fax: 205-655-5811
E-mail: mhendry@axys.com

For bioassays:

Edmund Canaria, Laboratory Manager, Toxicology Services
EVS Environment Consultants Limited
195 Pemberton Avenue
North Vancouver, B.C. V7P 2R4
Canada
Phone: 604-986-4331
Fax: 604-662-8548
E-mail: ecanaria@evsenvironment.com or ecanaria@golder.com

2.0 SYSTEMATIC PLANNING PROCESS

This QAPP is a tool to implement procedures to ensure that the quality of the data collected is known and documented. The following sections discuss what measurements will be used to assess the project Quality Assurance objectives, specifically precision, accuracy, representativeness, completeness, and comparability (PARCC). PARCC objectives are summarized in Table 1.

2.1 Project-Specific Objectives

The overall objective of these assessment activities is to address whether chemical concentrations in sediments at investigation sites pose a potential risk to human health and the environment. The overall quality assurance objectives for this project are to develop and implement procedures that will ensure the collection of representative data of known, acceptable, and defensible quality. To accomplish these goals, the assessment activities will employ field procedures and analytical methods designed to provide data of sufficient quality and quantity to allow comparison to screening criteria based on the most stringent applicable standards and to determine if subsequent cleanup levels have been met or if additional actions are needed.

Chemical analyses to be performed on the sediment, tissue and equipment rinsate blank samples are USEPA Target Analyte List (TAL) metals, PAHs, organochlorine pesticides, polychlorinated biphenyls (PCBs) as congeners, and polychlorinated dibenzo-p-dioxins and dibenzofurans (dioxins/furans). Sediments will also be analyzed for total organic carbon (TOC), grain size, and percent moisture; tissues will also be analyzed for percent lipids. Bioassays to be performed are sediment toxicity and bioaccumulation tests. Project-specific objectives, parameters to be measured and analytical methods are presented in Table 2.

Specific quality assurance objectives are established to ensure that the quality of the data can be determined and documented. Specific objectives for this project are:

- Establish sampling techniques that ensure the analytical data are representative of the locations sampled.

- Establish analytical detection levels to meet screening criteria, or as reasonably achievable.
- Collect and analyze a sufficient number of replicate field samples to establish overall sampling and analytical precision.
- Collect and analyze a sufficient number of equipment rinsate blank samples to evaluate the potential for contamination from sampling equipment and sample handling techniques.
- Analyze a sufficient number of matrix spike/matrix spike duplicate samples to evaluate results against numerical quality assurance goals for accuracy.

2.2 Target Reporting Limits and Screening Criteria

Target reporting limits (TRLs) and screening criteria for chemical constituents are presented in Table 3. The TRLs were provided by the analytical laboratory and were selected to meet the screening criteria values. Interference in individual samples may result in an increase in reporting limits. Reporting limits will also increase with increasing water content in sediment samples.

2.3 Precision

Precision refers to the reproducibility of repetitive measurements. Precision for chemical analyses will be evaluated using field replicate samples, laboratory matrix spike/matrix spike duplicate samples, and laboratory matrix duplicate samples. Precision will be expressed as the Relative Percent Difference (RPD) between samples, which is computed as:

$$RPD = \frac{(S - D)}{[(S + D)/2]} x100$$

Where: *S = Initial sample result*
D = Duplicate sample result

The precision attainable in the laboratory is a function of the relative homogeneity of the sample material collected in the field. As the sample material becomes more homogeneous, the ability to select similar aliquots of sample increases, and the relative precision of the duplicate analyses improves (i.e., the range of analytical values decreases). Factors that could affect the precision of duplicate analyses will be noted by samplers in their field log books. These factors may include obvious stratification of material, degree of sorting of particle sizes, the presence of multi-phase materials, color variations in the sample material, and any other factor that indicates the degree of heterogeneity of the sample.

If measured RPD values exceed limits normally associated with the methods and the equipment used, the data will be reviewed for the presence of sample characteristics that could result in lower precision. If large RPD values cannot be related to obvious sample characteristics, the method will be evaluated to determine if the difference results from sample preparation and handling.

2.4 Accuracy

Accuracy refers to the difference between the reported test results and the true value of the parameter being measured. Accuracy of chemical analyses will be evaluated in the laboratory using additions of known concentrations of analytes to sample matrices (matrix spikes, laboratory control samples, organic surrogate compounds) and standard reference materials. Matrix spike samples are used to assess the potential positive and negative interferences caused by the sample material itself. Sufficient volumes of sample material will be submitted to the analytical laboratory for analyses related to accuracy. A minimum of one matrix spike/matrix spike duplicate (MS/MSD) or MS sample per 20 samples will be analyzed by the laboratory.

Accuracy is typically expressed as percent recovery, which is calculated as follows:

$$\%\ Recovery = \frac{X_s - X_u}{SA}\ x\ 100$$

Where: X_S = *measured value of the spiked sample,*

X_U = *measured value of the unspiked sample, and*

SA = *known amount of the spike in the sample.*

If measured recoveries for spiked samples exceed limits normally associated with the methods or equipment used, the data will be reviewed for the presence of sample characteristics that could result in lower accuracy. If noncompliant matrix spike recoveries cannot be related to obvious sample characteristics, the method will be evaluated to determine if the difference results from sample preparation and handling. If measured recoveries for laboratory control samples and organic surrogate compounds do not meet laboratory control limits for the equipment being used, corrective action will be taken.

2.5 Representativeness

Representativeness refers to how closely the results measured in the laboratory reflect the actual conditions in the medium sampled. The QA objective for representativeness is addressed through use of appropriate sampling methods and sample handling procedures.

Where thorough mixing of samples is not possible, or other characteristics of the sample hinder thorough mixing, these conditions will be documented during sample preparation and the results will be reviewed with consideration of the possible non-representative conditions.

Representativeness is also evaluated through the use of equipment rinsate blanks. These samples will be analyzed to determine if contamination is being introduced to the samples through sampling equipment in the field. Laboratory method blanks will also determine how representative the analyses are of the media sampled. Sufficient blank samples will be used to ensure that representativeness can be assessed.

2.6 Completeness

Completeness refers to the percentage of all measurements made that are judged to be valid measurements. Objectives for completeness are based, in part, on the subsequent uses of the data (i.e., the more critical the use, the greater the completeness objective). The objectives for completeness of samples is expressed as percentages that refer to the minimum acceptable percentage of samples received at the laboratory in good condition and acceptable for analysis. The objective of completeness for sample collection is 95 percent. This objective will be met through the use of proper sample containers, proper sample packaging procedures to prevent breakage during shipment, proper sample preservation, and proper labeling and chain-of-custody (COC) procedures.

The objectives for completeness of chemical analyses are also expressed as percentages and refer to the percentages of analytical requests for which usable analytical data are produced. The initial objective for completeness of chemical analyses in the laboratory is 95 percent. This objective will be reviewed after performance data are available for each sample type analyzed. The objective may be revised upward or downward based on actual performance, but will not be revised downward without making and documenting a reasonable effort to identify and rectify the limiting factor(s). Based on actual laboratory performance in analysis of samples, individual completeness objectives for individual analytical methods may be developed.

Loss of analytical data will initiate a corrective action to identify the cause of the loss and prevent recurrence.

2.7 Comparability

Comparability refers to the ability to compare the results of various measurements. The objective for comparability is to obtain measurements that are directly comparable (i.e., similar analytical methods and data reported in the same units over time). The comparability objective will be met through use of recognized chemical analytical methods (e.g., USEPA 2004a).

2.8 Sampling Design

USEPA requirements call for the use of a systematic process in planning the data collection activities through the Data Quality Objectives (DQO (USEPA 1998, 2001). The systematic planning approach generally followed the DQO process. Although the quantitative elements of the DQO process were not suitable for the specific conditions of this project, the qualitative elements of the process were adapted as appropriate. The considerations used in the study design are discussed in the FSP.

3.0 FIELD QUALITY CONTROL

3.1 Field Sampling

A Field Sampling Plan (FSP) was developed for the sampling project covered by this QAPP (NOAA, August 2005). Environmental media covered by this QAPP include sediment that will be analyzed for contaminants and used to perform sediment toxicity tests and bioaccumulation tests. Additional measurements will be taken in the field.

3.1.1 Sediment Sampling

Sediment samples will be collected using a "petit Ponar" grab (dredge), as described in section 3.3 of the FSP. Samples will be collected at each location and homogenized in a stainless steel mixing bowl with a stainless steel spoon. The sediment will be thoroughly mixed before filling the sample containers.

Non-disposable sediment sampling equipment will be decontaminated between each sampling location according to the procedures outlined in section 3.4 of this document and section 3.8.1 of the FSP.

Samples will be packaged, labeled, and shipped as described in section 3.4 of the FSP.

3.1.2 In-Field Measurements

Field measurements will include water depth, determination of the sampling location coordinates using a hand-held Global Positioning System (GPS) unit, and noting general stream characteristics as described in section 3.4 of the FSP.

3.2 Field Quality Control

All field quality control samples will be documented in the field logbook, and verified by the Project QA Coordinator. The field quality control samples that will be collected during assessment activities are discussed in the following subsections.

3.2.1 Equipment Rinsate Blanks

Equipment rinsate blanks are used to assess whether and to what degree contamination is crossing from one sample to the next during sample collection or processing. A rinsate blank is created by rinsing the sampling equipment after it has undergone decontamination procedures between samples, using laboratory-supplied deionized water. The rinsate water is collected and analyzed for the same parameters as the corresponding field samples. A minimum of one rinsate blank will be submitted for every 20 samples processed in the field or one per day, whichever is most frequent.

3.2.2 Field Duplicate Samples

One field duplicate sample will be collected per reach (Hyde Park Lake, East Gill Creek, and Gill Creek), as described in section 3.3 of the FSP; locations will be determined based on field conditions (e.g., ease of obtaining enough material). The duplicate samples will be collected from the same homogenized material as the corresponding field sample and will be submitted blind to the laboratory for the same analyses as the corresponding field samples.

3.2.3 MS/MSD Samples

Sufficient sample material will be collected during the sampling activities to allow for analysis of matrix spike/matrix spike duplicate (MS/MSD) samples at a frequency of one MS/MSD for every 20 field samples collected. The field samples intended for MS/MSD analysis will be designated in the field and identified on the chain-of-custody document. Preferably, the MS/MSD sample will be from the same sample location as an associated field replicate. The MS/MSD sample will be analyzed for the same parameters as the associated field samples and will be part of the same analytical batch.

3.3 Field Documentation

Thorough recordkeeping is the most important aspect of sample custody. All original data recorded in field notes, chain-of-custody (COC) records, and other forms are written with permanent, waterproof ink; erasures of data will not be made. If an error is made on a document, the individual making the entry will correct the document by crossing a single line through the error, entering the correct information and dating and initialing the correction. Any subsequent error discovered on a document will be corrected in the same manner (i.e., crossed through, initialed, and dated).

The sample labeling system is described in section 3.4 of the FSP.

3.3.1 Field Notes

A field notebook will be maintained throughout the sampling effort and will contain information for each station occupied and each sample taken. It will have numbered pages, and each entry will be initialed by the recorder. The field notebook will be organized by date and will include the station number, notes on sampling crew and weather, any sampling problems, deviations from the work plan, and general observations and comments.

3.3.2 Chain-of-Custody Procedures

The purpose of the COC procedures is to document the possession of the samples from collection through storage and analysis to reporting. The principal documents used to identify samples and to document possession are COC forms, field logbooks, and field tracking forms. COC forms will become part of the permanent record of sample handling and shipment. All COC forms will be completed in indelible ink. Field sampling personnel are responsible for the care and security of samples from the time of collection until turned over to the shipping agent.

A sample is considered to be in one's custody if it is: 1) in plain view at all times or in the physical possession of the sampler; 2) stored in a secured location (under lock) with restricted access where tampering is prevented; or, 3) in a container that is secured with custody seals such that the sample cannot be reached without breaking the seal.

Each COC form will contain the following information:

- Sample identification numbers,
- Date and time of sampling,
- Type of sample and number of containers associated with each sampling point,
- Indication of preservatives used,

- List of analytes requested,
- Shipping air bill number, and
- Transfer of custody acknowledgment.

Samples will be stored in coolers supplied by the laboratory. The samples will be maintained at a temperature of 4°C, +/-2°C with blue ice. When the sampling is completed and the cooler packed for shipping, the COC record will be signed by a member of the sampling team. Any corrections will be made to the record with a single strike that is dated and initialed. The COC record will be placed and sealed in a plastic bag and taped to the inside top of the cooler. The cooler will be taped shut and two signed and dated custody seals will be affixed so as to be broken if the cooler is opened. One seal will be placed on the front right-hand side of the lid. The other seal will be placed on the back left hand side of the lid.

3.4 Equipment Decontamination

To minimize the potential for cross-contamination of samples, equipment used during sampling activities will be decontaminated prior to use at each sampling site. Personnel who may contact sample media will wear nitrile gloves. Prior to sample handling, new gloves will be donned; gloves will be changed between each unique sampling event. Decontamination will be conducted on plastic sheeting. Work surfaces will be covered with aluminum foil. The sampling and mixing equipment (Ponar dredge, bowls, spoons, and spatulas) will be decontaminated after sampling at each sample location.

The Ponar dredge will be decontaminated between stations as follows:

1. Wash with site water and phosphate-free detergent, if necessary to remove all visible residues.
2. Rinse with site water.
3. Rinse with distilled water and allow to air dry.

The homogenization bowls and spoons will be decontaminated by:

1. Wash with site water and phosphate-free detergent, if necessary to remove all visible residues.
2. Rinse with site water.
3. Rinse with distilled water and allow to air dry.

4. Rinse with residue-free methanol and allow to air dry.
5. Cover with aluminum foil until used again.

4.0 LABORATORY QUALITY CONTROL

This section discusses sampling handling requirements, analytical methods, and laboratory quality control criteria.

4.1 Laboratory Quality System

Each laboratory will have an approved laboratory quality assurance plan (LQAP) covering its own procedures and meeting the requirements of EPA QA/R-5 (USEPA 2001). The LQAP must specify requirements for equipment testing, inspection, maintenance, and calibration.

4.2 Sample Receipt and Handling

The Laboratory Project Manager will ensure that all COC forms are properly signed upon receipt of the samples, and will note observations regarding sample integrity on the COC forms (e.g., broken containers, leakage, damaged cooler, etc.). The laboratory will contact the Project Manager or Project QA Coordinator within 24 hours if discrepancies are discovered between the COC forms and the sample shipment upon receipt. The Laboratory Project Manager will specifically note any coolers that do not contain ice packs or are not sufficiently cold (4 ± 2 °C) upon receipt. Each sample will be assigned a unique laboratory number.

The Laboratory Project Manager will ensure that a sample-tracking record is maintained that follows each sample through all stages of laboratory processing. The sample-tracking record must contain at a minimum the name/initials of responsible individuals performing the analyses, dates of sample extraction/preparation and analysis, and the type of analysis being performed.

4.3 Analytical Quality Control

The laboratories performing chemical analyses will measure TAL metals, PAHs, organochlorine pesticides, PCBs (as congeners), dioxins/furans, TOC, grain size, lipid content and moisture content. The required methods of analysis and associated TRLs are identified in Table 3.

Prior to the analysis of any samples, the laboratory will establish an initial calibration curve for each analytical instrument, as specified in the analytical method.

Results of the quality control samples from each sample extraction or preparation batch will be reviewed by the analyst immediately after analysis. The quality control sample results will then be evaluated to determine whether control limits have been exceeded. If control limits are exceeded in any sample or analytical batch, the Project QA Coordinator will be contacted immediately, and corrective action (e.g., method modifications followed by reprocessing the affected samples) will be initiated prior to processing subsequent samples.

The following laboratory quality control samples will be analyzed, as appropriate to the method. The frequency will be one sample per analytical batch (≤ 20 samples).

- Laboratory control sample
- Matrix duplicate
- Matrix spike/matrix duplicate
- Method or preparation blank

4.4 Other Laboratory QA Requirements

The laboratory must demonstrate their continued proficiency by participation in interlaboratory comparison studies and through repeated analysis of certified reference materials, calibration checks, laboratory reagent blanks, and spiked samples.

4.5 Sediment Toxicity and Bioaccumulation Testing Quality Control

The laboratory performing biological testing will perform 10 day sediment toxicity tests using *Chironomus tentans* and *Hyallela azteca*, and bioaccumulation tests using **Lumbriculus variegatus** (Table 2). The tests will be initiated with 2 weeks of sample collection.

Sediment toxicity and bioaccumulation testing will include concurrent reference toxicant tests using established standards solutions at 3 concentrations. Temperature, pH, dissolved oxygen, conductivity, ammonia, hardness and alkalinity will be measured in the overlying waters on

Day 0 and Day 10. Temperature and DO will be also be measured daily. Bulk and/or interstitial ammonia will be measured n Day 0 and/or Day 10.

All biological tests will include negative (clean) controls and reference sediments. The negative controls will use clean media (e.g. purchased fine silica sand). The reference sediments will be provided to the laboratory by NOAA and will be collected from an area known to be free from chemical contamination.

The laboratory will perform a QA review of the data generated. The QA process will include reviewing the daily monitoring data and test results to ensure the tests are valid and data quality objectives are met.

4.6 Corrective Action

The need for corrective action may be identified by the technical staff during the course of their work, or through quality assurance audits. Each individual performing sample collection, laboratory, or data processing activities will be responsible for notifying the appropriate supervisory personnel of any circumstance that could affect the quality or integrity of the data. If control limits are exceeded, the Project QA Coordinator will be contacted immediately, and corrective action (e.g., method modifications followed by reprocessing the affected samples) will be indicated before processing subsequent samples.

Events or conditions that produce, or may produce, adverse effects on the quality of data will be addressed through documented corrective action. If, during the course of an audit, the Project QA Coordinator, Laboratory Project Manager, or analytical staff discovers such events or conditions, corrective actions will immediately be initiated. The QA Coordinator may, at his discretion, order the stoppage of work until corrective actions have been identified and implemented. The Project QA Coordinator will be responsible for the following:

- Identifying the cause of the event or condition;
- Identifying actions required to prevent reoccurrence of event or condition;
- Identifying any required changes to the FSP, the QAPP, or referenced procedures;
- Determining the impact of the event or condition on the quality of the data;

- Determining if these impacts will cause the data to be unacceptable for meeting the objectives of the project; and
- Identifying unacceptable data that must be replaced through re-sampling or reanalysis.

4.6.1 Deviations

Deviations typically result from unforeseen circumstances. Deviations apply when the quality of reportable data is indeterminate, i.e., when no objective evidence is available to substantiate data quality or to indicate that established procedures and requirements were met. All deviations from this QAPP must be approved by the Project Manager and documented in writing. The following are guidelines to resolving deviations:

- The need for corrective action at the laboratory level, such as broken samples, improper instrument calibration, etc., will be addressed by the analyst.

- Corrective actions for results outside established quality assurance objectives are addressed in the following section.

- Issues that affect cost, schedule, or performance of the project will be reported to the Project Manager. The Project Manager will then be responsible for evaluating the overall impact to the project and implementing the necessary corrective actions.

- Deficiencies identified through QA/QC verification activities will be brought to the attention of the Project Manager. Implementation of corrective action will be the responsibility of the Project QA Coordinator.

4.6.2 Corrective Action for Quality Control Exceedances

The Project QA Coordinator will be notified immediately if any quality control sample exceeds the control limits. The analyst will identify and correct the anomaly before continuing with the sample analysis. The Laboratory Project Manager will document the corrective action taken in a memorandum submitted to the Project QA Coordinator within 5 days of the initial notification. A narrative describing the anomaly, the steps taken to identify and correct the anomaly and the treatment of the relevant sample batch will be submitted with the data package in the form of a cover letter. Corrective actions may include, but are not limited to, review of data and calculations, flagging of suspect data (flagging requirements are addressed in Section 5.3), or re-extraction and/or reanalysis of individual or entire batches of samples.

Method blank analyte concentrations detected at up to 5 times the TRL should be noted in the report narrative, and analysts should qualify data as having blank contamination. If the analyte is detected in the associated samples, the data will be flagged with a "B." If method blank analytes are detected at concentrations greater than 5 times the TRL, all associated samples will be re-extracted/re-digested.

4.7 Laboratory Data Deliverables

The laboratories will be responsible for internal checks on data reporting and will correct errors identified during the quality assurance review. Close contact will be maintained with each laboratory to resolve any quality control problems n a timely manner. The laboratories will provide complete data packages, and include information on all aspects of the tests. Analytical chemistry data packages will contain sufficient information to allow independent validation according to USEPA Contract Laboratory Program National Functional Guidelines (see Section 5.3).

5.0 CHEMICAL DATA REDUCTION, VALIDATION, MANAGEMENT AND REPORTING

The project records will be maintained by NOAA. All original data and documentation generated by the laboratory will be kept in a secure location by NOAA for 10 years after the data have been validated. COC procedures will be followed for all laboratory data and data documentation, whether in hard copy or electronic format. All laboratory data and data documentation, including electronic data files, will be submitted by the laboratory a data package to NOAA, as appropriate, for the validation of chemistry data results. All data and data documentation are the responsibility of the Project Manager.

5.1 Data Reduction

Data reduction is the process by which original analytical measurements are converted or reduced in a specific format to facilitate analysis. Data reduction includes all processes that change the numerical value of the raw data, and requires that all aspects of sample preparation that could affect the test results (such as sample volume analyzed or dilutions required) be taken into account in the final result.

All laboratory data reduction will be performed in accordance with the appropriate methodology and will be presented in the sample results. It is the laboratory analyst's responsibility to reduce the data. The reduction process will be further reviewed by the Laboratory Project Manager, the Project QA Coordinator, and independent reviewers.

5.2 Data Management and Raw Data Reporting

Electronic data files will be provided in tab-delimited format compatible for import into Microsoft Excel. The following will be submitted in separate data fields by the laboratory to the Project QA Coordinator:

- Field sample number
- Laboratory sample number
- Sample matrix
- Date of receipt
- Date of analysis

- Date of extraction
- Analytical method
- Dilution Factor
- Analyte
- Analytical results
- Data qualifiers
- Detection limit or quantitation limit
- Units

All raw data (chromatograms, quantification reports, integration reports, etc.), including initial continuing calibrations associated with the analyses, will be filed at the laboratory for a period of seven years and can be made available upon request. NOAA will be responsible for retaining the reports and data related to this project for a period of 10 years.

The standard units that will be used to report data in dry weight are listed in Table 5.

5.3 Data Validation

The Project QA Coordinator will coordinate independent validation of the data and will be responsible for ensuring that all analyses performed by the laboratory are correct, properly documented, complete, and satisfy the project quality assurance objectives.

The Project QA Coordinator will discuss any discrepancies and requests for additional, corrected data with the laboratory prior to issuing the formal data validation report. All contacts with the laboratory will be documented on a communication report. Review procedures used and findings made during data validation will be documented on worksheets. A validation report will be prepared that will summarize quality control results, qualifiers, and possible data limitations. Only validated data with appropriate qualifiers will be released for general use.

All analytical data from laboratory analyses will be validated using guidelines specified in the following documents, as applicable:

- USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (USEPA 1999);

- USEPA Contract Laboratory Program National Functional Guidelines for Chlorinated Dioxin/Furan Data Review (USEPA, 2002); and

- USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (USEPA, 2004b).

Specific method documentation will also be consulted as necessary (e.g., SW-846, ASTM methods).

5.3.1 Precision

Validation of analytical data will determine whether laboratory precision goals have been met. The Project QA Coordinator will review data validation reports and analytical data packages to determine if precision goals have been met. If these criteria are not met, a careful examination of the sampling techniques, sample media, and analytical procedure will be conducted to identify the cause of the poor precision and to evaluate the usability of the data.

5.3.2 Accuracy

Validation of analytical data will determine whether accuracy goals have been met. The sampling accuracy will be determined by evaluation of field blank analytical results. If target analytes are present in the field blanks, a careful assessment of the usability of the associated data will be made, which will take into account the level of contamination found in the blank compared with that of the samples.

5.3.3 Completeness

The completeness goal is 95 percent for both sampling and analyses. Field samples submitted for analysis and received by the analytical laboratory in good condition will be compared to the derived number of samples (scheduled number of samples to be collected). The percentage completeness will be calculated and reported as the percentage field completeness. The percentage of samples analyzed by the laboratory will be compared to the number of useable analyses that are produced. This percentage will be calculated and reported as the percentage laboratory completeness. Each of these completeness results will be compared to completeness goals. Total completeness percentages will also be calculated (useable sample divided by desired sample data times 100) and reported as total completeness by matrix and analysis. If completeness goals are not met, a determination will be made as to whether additional sampling and analysis are required to meet project data needs.

5.4 Data Reporting

Data are not considered final until validated. All data, including laboratory and field quality control sample results, will be summarized in a quality assurance report. The quality assurance reports will be included as an appendix to the final document and will summarize the results of quality control samples, data usability and any other information that affects the quality of the data. In addition, the validation process will include a summary of the sampling event, including deviations from this QAPP and actions taken to address those deviations.

6.0 REFERENCES

American Society for Testing and Materials (ASTM). 1995. *ASTM E 1706-95b: Standard Test Methods for Measuring the Toxicity of Sediment-Associated Contaminants with Freshwater Invertebrates*.

American Society for Testing and Materials (ASTM). 2000. *Standard guide for measuring the toxicity of sediment-associated contaminant with freshwater invertebrates. Method E 1706-95b*. In: 2000 Annual Book of ASTM Standards, Volume 11.05.

American Society for Testing and Materials (ASTM). 2004. *Standard guide for measuring the toxicity of sediment-associated contaminant with freshwater invertebrates. Method E 1706-00*. In: 2004 Annual Book of ASTM Standards, Volume 11.05.

Buchman, M.F. 1999. *NOAA Screening Quick Reference Tables*. NOAA Hazmat Report 99-1, Coastal Protection and Restoration Division. 12 pp. Available: <http://response.restoration.noaa.gov/cpr/sediment/squirt/squirt.html>.

Canadian Council of Ministers of the Environment. 2003. The Canadian Sediment Quality Guidelines for the Protection of Aquatic Life, in: Canadian Environmental Quality Guidelines, Summary Table, December. Available:

<http://www.ccme.ca/assets/pdf/e1_062.pdf>

MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. "Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems." In: Archives of Environmental Contamination Toxicology 39: 20-31.

National Oceanic and Atmospheric Administration (NOAA). 2005. *Forest Glen Subdivision Superfund Site, Niagara County, New York: Field Sampling Plan for the East Gill Creek, Gill Creek, and Hyde Park Lake Characterization Study*. July.

New York State Department of Environmental Conservation. 1999. *Technical Guidance for Screening Contaminated Sediments.* Division of Fish, Wildlife and Marine Resources. January 25.

Ontario Ministry of the Environment. 1993. *Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario.* PIBS 1962, ISBN 0-7729-9248-7, August.

U.S. Environmental Protection Agency (USEPA). 1989. *Preparing Perfect Project Plans*. USEPA Risk Reduction Engineering Laboratory. EPA/600/9-89/087. October.

U.S. Environmental Protection Agency (USEPA). 1998. *EPA QA/G-5: USEPA Guidance for Quality Assurance Project Plans*. Office of Research and Development. EPA/600/R-98/018. February.

U.S. Environmental Protection Agency (USEPA). 1999. *Contract Laboratory Program National Functional Guidelines for Organic Data Review*. Office of Solid Waste and Emergency Response. EPA-540/R-99-08, OSWER 9240.1-05A-P (PB99-963506). October. Available: <http://www.epa.gov/superfund/programs/clp/download/fgorg.pdf>.

U.S. Environmental Protection Agency (USEPA). 2000. *EPA QA/G-4: Guidance for the Data Quality Objectives Process*. Office of Research and Development. Available: <http://www.epa.gov/quality/qs-docs/g4-final.pdf>. August.

U.S. Environmental Protection Agency (USEPA). 2004a. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.* Sixth edition. SW 846. Office of Solid Waste and Emergency Response. November. Available: <http://www.epa.gov/SW-846/main.htm>.

U.S. Environmental Protection Agency (USEPA). 2004b. *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*. Office of Solid Waste and Emergency Response. EPA 540-R-04-004, OSWER 9240.1-45. October. Available: <http://www.epa.gov/superfund/programs/clp/download/inorgfg10-08-04.pdf>.

U.S. Environmental Protection Agency (USEPA). 2001. *EPA QA/R-5: EPA Requirements for Quality Assurance Project Plans*. Office of Research and Development. EPA/240/B-01/003. March. Available: <http://www.epa.gov/quality/qs-docs/r5-final.pdf>.

U.S. Environmental Protection Agency (USEPA). 2002. *Contract Laboratory Program National Functional Guidelines for Chlorinated Dioxin/Furan Data Review*. Office of Solid Waste and Emergency Response. EPA 540-R-02-003, OSWER 9240.1-37. August. Available: <http://www.epa.gov/superfund/programs/clp/download/dioxnfg.pdf>.

U.S. Environmental Protection Agency (USEPA) and U.S. Army Corps of Engineers (USACE). 1998. *Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S.: Testing Manual (Inland Testing Manual)*. EPA/823/B-98-004. February. Available: <http://www.epa.gov/waterscience/itm/ITM/>.

TABLES

Table 1. PARCC Objectives

PARCC Objective	Goal
Precision	Limits normally associated with the analytical method or the equipment used (these may be laboratory-derived criteria); minimum of 1 duplicate sample per 20 samples.
Accuracy	Limits normally associated with the analytical method or the equipment used (these may be laboratory-derived criteria); minimum of 1 MS/MSD sample per 20 samples.
Representativeness	Ensure that sampling locations are selected properly and an adequate number of samples are collected, per the Field Sampling Plan (FSP). "Blind" field replicates will be used to assess representativeness. Results should be within one-half order of magnitude (factor of five) or less for a typical analysis. Results with a Relative Percent Difference (RPD) of +/- 35% will be considered to show good comparability.
Completeness	95 percent sample collection, 95 percent chemical analyses.
Comparability	Use of recognized analytical methods.

Table 2. Parameters to be Measured and Project Objectives

Analysis	Method	Project Objectives
Chemical Analyses (Sediment, Tissues, and Rinsates)		Evaluate the sediment concentrations of contaminants of concern in East Gill Creek, Gill Creek, and Hyde Park Lake. Analyze *Lumbriculus variegatus* tissues from bioaccumulation tests and determine biota-sediment accumulation factors (BSAF).
TAL Metals		
Sediment	USEPA 6010B/200.8/7471A	
Tissues	USEPA 6010B/7000A/7471A	
Rinsates	USEPA 6010B/200.8/7470A	
PAHs	USEPA 8270D	
Pesticides	USEPA 8081A/8082	
Dioxins/Furans	USEPA 1613B	
Conventional Analyses (Sediment)		
Total Organic Carbon	Plumb 1981	
Moisture content	ASTM D2216-90	
Grain size	ASTM D422	
Conventional Analyses (Tissues)		
Lipid content	Bligh & Dyer (mod.)	
Bioassays		Determine whether bulk sediments from East Gill Creek, Gill Creek, and Hyde Park Lake adversely affect the growth and survival of benthic organisms. Determine whether contaminants in East Gill Creek, Gill Creek, and Hyde Park Lake bioaccumulate.
10-day *Chironomus tentans* sediment toxicity tests	USEPA 2000 100.2	
10-day *Hyalella azteca* sediment toxicity tests	USEPA 2000 100.1	
4-day *Lumbriculus variegatus* screening tests	USEPA 2000 100.3	
28-day *Lumbriculus variegatus* bioaccumulation tests		

Table 3a. Laboratory Target Reporting Limits and Screening Criteria – TAL Metals

Target Analyte Metal	Sediment (mg/kg, dry wt.)		Tissue (mg/kg, wet wt.)	Rinsates (μg/L)
	Reporting Limit [1]	Screening Criteria	Reporting Limit	Reporting Limit
Aluminum	5.0	25,500 [a]	1.0	50
Antimony	5.0	2.0 [b]	1.0	50
Arsenic	0.5	5.9 [c]	0.02	0.2
Barium	0.3	-	0.06	3
Beryllium	0.1	-	0.02	1
Cadmium	0.2	0.6 [b]	0.04	2
Calcium	5.0	-	1.0	50
Chromium	0.5	26 [b]	0.1	5
Cobalt	0.3	-	0.06	3
Copper	0.2	16 [b]	0.04	2
Iron	5.0	20,000 [b]	1.0	50
Lead	1	31 [b]	0.04	1.0
Magnesium	5.0	-	1.0	50
Manganese	0.1	460 [b]	0.02	1
Mercury	0.05	0.15 [b]	0.01	0.1
Nickel	1.0	16 [b]	0.2	10
Potassium	50	-	10	500
Selenium	2	-	0.04	0.5
Silver	0.3	1.0 [b]	0.06	3
Sodium	50	-	10	500
Thallium	0.2	-	0.02	0.2
Vanadium	0.3	-	0.06	3
Zinc	0.6	98 [a]	0.12	6

[1] Assumes 100% solids; increasing water content will reduce reporting limit.
"-" = not available

Sources:
[a] Lowest ARCs *H. azteca* Threshold Effects Limit (TEL) (Buchman, 1999)
[b] Lowest Effect Level (LEL) (New York State, 1999)
[c] Interim Sediment Quality Guideline (ISQG) (Canadian Council of Ministers of the Environment, 2003)
[d] Consensus-based Threshold Effect Concentration (TEC)(MacDonald, Ingersoll and Berger, 2000)

Table 3b. Laboratory Target Reporting Limits and Screening Criteria – PAH (SIM)

PAH Compound	Sediment (µg/kg, dry wt.)		Tissue (µg /kg, wet wt.)	Rinsates (µg /L)
	Reporting Limit [1]	Screening Criteria	Reporting Limit	Reporting Limit
Naphthalene	6.7	34.6 [a]	5.0	0.1
2-Methylnaphthalene	6.7	20.2 [a]	5.0	0.1
Acenaphthylene	6.7	5.87 [a]	5.0	0.1
Acenaphthene	6.7	6.71 [a]	5.0	0.1
Fluorene	6.7	21.2 [a]	5.0	0.1
Phenanthrene	6.7	41.9 [a]	5.0	0.1
Anthracene	6.7	46.9 [a]	5.0	0.1
Fluoranthene	6.7	111 [a]	5.0	0.1
Pyrene	6.7	53.0 [a]	5.0	0.1
Benzo(a)anthracene	6.7	31.7 [a]	5.0	0.1
Chrysene	6.7	57.1 [a]	5.0	0.1
Benzo(b)fluoranthene	6.7	31.9 [a]	5.0	0.1
Benzo(k)fluoranthene	6.7	27.2 [b]	5.0	0.1
Benzo(a)pyrene	6.7	31.9 [a]	5.0	0.1
Indeno(1,2,3-cd)pyrene	6.7	17.32 [b]	5.0	0.1
Dibenz(a,h)anthracene	6.7	6.22 [a]	5.0	0.1
Benzo(g,h,i)perylene	6.7	-	5.0	0.1
Dibenzofuran	6.7	-	5.0	0.1
Total PAH		1,610 [c]		

[1] Assumes 100% solids; increasing water content will reduce reporting limit.

Sources:
[a] Interim Sediment Quality Guideline (ISQG) (Canadian Council of Ministers of the Environment, 2003)
[b] Lowest ARCs *H. azteca* Threshold Effects Limit (TEL) (Buchman, 1999)
[c] Consensus-based Threshold Effect Concentration (TEC)(MacDonald, Ingersoll and Berger, 2000)

Table 3c. Laboratory Target Reporting Limits and Screening Criteria – Pesticides

Pesticide Compound	Sediment (μg/kg, dry wt.)		Tissue (μg /kg, wet wt.)	Rinsates (μg /L)
	Reporting Limit [1]	Screening Criteria	Reporting Limit	Reporting Limit
alpha-BHC	1	6 [a]	2.5	0.05
beta-BHC	1	5 [a]	2.5	0.05
delta-BHC	1	-	2.5	0.05
gamma-BHC (Lindane)	1	0.94 [c]	2.5	0.05
Heptachlor	1	1 [c]	2.5	0.05
Aldrin	1	2 [a]	2.5	0.05
Heptachlor Epoxide	1	0.6 [b]	2.5	0.05
Endosulfan I	1	0.3 [c]	2.5	0.05
Dieldrin	2	1.90 [d]	5	0.1
4,4'-DDE	2	1.42 [e]	5	0.1
Endrin	2	2.22 [d]	5	0.1
Endosulfan II	2	0.3 [c]	5	0.1
4,4'-DDD	2	3.54 [e]	5	0.1
Endosulfan Sulfate	2	-	5	0.1
4,4'-DDT	2	1.19 [b]	5	0.1
Methoxychlor	10	6 [c]	25	0.5
Endrin Ketone	2	-	5	0.1
Endrin Aldehyde	2	-	5	0.1
gamma Chlordane	1	-	2.5	0.05
alpha Chlordane	1	-	2.5	0.05
Total Chlordane		3.24 [d]		
Toxaphene	100	0.1 [c]	25	5.0

[1] Assumes 100% solids; increasing water content will reduce reporting limit.

Sources:
[a] Lowest Effect Level (LEL)(Ontario Ministry of the Environment, 1993)
[b] Interim Sediment Quality Guideline (ISQG) (Canadian Council of Ministers of the Environment, 2003)
[c] Benthic Aquatic Life Chronic Toxicity (assuming 1% TOC) (New York State, 1999)
[d] Consensus-based Threshold Effect Concentration (TEC)(MacDonald, Ingersoll and Berger, 2000)
[e] Threshold Effects Limit (TEL) (Buchman, 1999)

Table 3d. Laboratory Target Reporting Limits and Screening Criteria – PCB Aroclors

PCB Aroclor	Sediment (µg/kg, dry wt.)		Tissue (µg /kg, wet wt.)	Rinsates (µg /L)
	Reporting Limit [1]	Screening Criteria	Reporting Limit	Reporting Limit
Aroclor 1016	4	7 [a]	20	0.1
Aroclor 1242	4	-	20	0.1
Aroclor 1248	4	30 [a]	20	0.1
Aroclor 1254	4	60 [b]	20	0.1
Aroclor 1260	4	5 [a]	20	0.1
Aroclor 1221	4	-	20	0.1
Aroclor 1232	4	-	20	0.1
Total Aroclors		14 [c]		

[1] Assumes 100% solids; increasing water content will reduce reporting limit.

Sources:
[a] Lowest Effect Level (LEL)(Ontario Ministry of the Environment, 1993)
[b] Interim Sediment Quality Guideline (ISQG) (Canadian Council of Ministers of the Environment, 2003)
[c] Benthic Aquatic Life Chronic Toxicity (assuming 1% TOC) (New York State, 1999)

Table 3e. Laboratory Target Reporting Limits (TRLs) and Screening Criteria – Dioxin/Furans

Dioxin/Furan Congener	Sediment (pg/g, dry wt.)		Tissue (pg/g, wet wt.)	Rinsates (pg /L)
	Reporting Limit[1]	Screening Criteria	Reporting Limit	Reporting Limit
Dioxin Congeners				
2,3,7,8-TCDD	0.059	0.85 [a]		
1,2,3,7,8-PeCDD	0.153	-		
1,2,3,4,7,8-HxCDD	0.172	-		
1,2,3,6,7,8-HxCDD	0.118	-		
1,2,3,7,8,9-HxCDD	0.172	-		
1,2,3,4,6,7,8-HpCDD	0.169	-		
OCDD	0.518	-		
Furan Congeners				
2,3,7,8-TCDF	0.077	-		
1,2,3,7,8-PeCDF	0.132	-		
2,3,4,7,8-PeCDF	0.143	-		
1,2,3,4,7,8-HxCDF	0.148	-		
1,2,3,6,7,8-HxCDF	0.154	-		
1,2,3,7,8,9-HxCDF	0.148	-		
2,3,4,6,7,8-HxCDF	0.090	-		
1,2,3,4,6,7,8-HpCDF	0.183	-		
1,2,3,4,7,8,9-HpCDF	0.081	-		
OCDF	0.381	-		

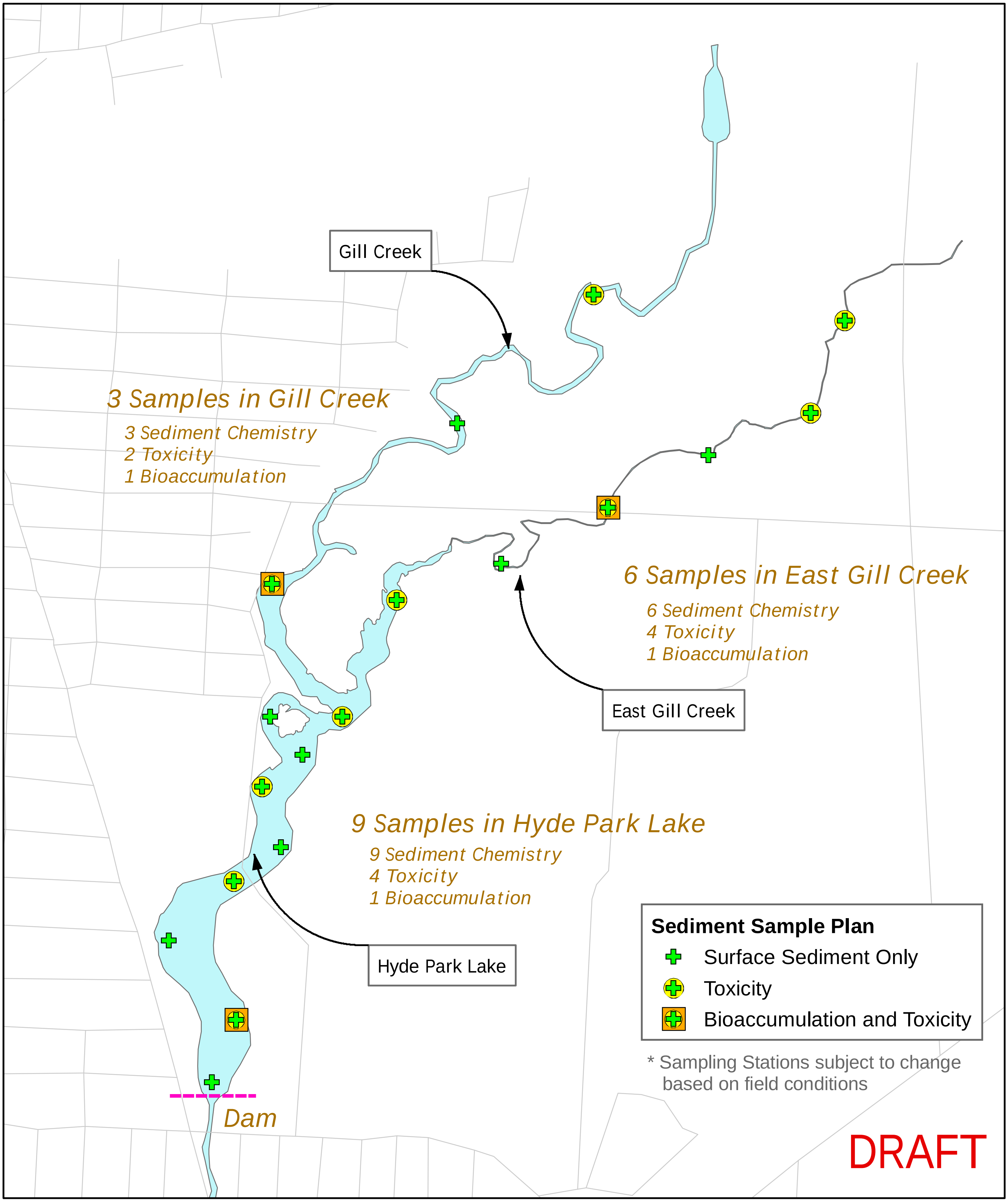
[1] Assumes 100% solids; increasing water content will reduce reporting limit; numbers represent laboratory method detection limit.

Sources:
[b] Interim Sediment Quality Guideline (ISQG), expressed as toxicity equivalency (TEQ) units per WHO, 1998 TEF values for fish (Canadian Council of Ministers of the Environment, 2003)

Table 4. Standard Reporting Units

Parameters	Units
Organic compounds (PAHs, PCBs, pesticides, dioxins/furans)	μg/kg
Metals	mg/kg
TOC, moisture	%
Grain size	μm

FIGURES



NOTES
Coordinate System & Grid:
UTM Zone 18 Meters NAD83
Orthophoto: NYGIS 2002
Hydrology digitized by NOAA CPRD
based on DRG, DOQQ
Sediment Chemistry at all locations
Bioaccumulation will be co-located
with toxicity

0 250 500 Meters

0 1,000 2,000 Feet

FIGURE 1. FOREST GLEN SEDIMENT SAMPLING PLAN

NOAA CPRD: BDS 09/07/2005
c:\gis\projects\ForestGlen\arc_projects\fg_base_083105.mxd